Annual Report

U. S. Coast & Geodetic Survey

FOR THE FISCAL YEAR 1949

Leo Otis Colbert, *Director*

U. S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1950

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 15 cents

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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March 22, 2005

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1949

U. S. DEPARTMENT OF COMMERCE

UNITED STATES
DEPARTMENT OF COMMERCE

CHARLES SAWYER, *Secretary*

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United States Coast and Geodetic Survey

LEO OTIS COLBERT, DIRECTOR

GENERAL STATEMENT

Functions of the Bureau

The Coast and Geodetic Survey, which in the beginning was known as the Coast Survey, was first organized in 1807 to survey and chart the then existing coastal waters of the United States, in the interest of promoting commerce between the various States and with foreign countries. The need to obtain precise instruments and the War of 1812 caused postponement of actual field work until 1816, when surveys were begun in the vicinity of New York. Later, the work of the Bureau was extended to the Pacific and Gulf coasts.

In 1871, the Bureau was authorized to provide the States with geographic positions and bench marks for the control of their topographic and geologic mapping. Other functions have been added to the Bureau's activities principally in the fields of aeronautical charting and seismology, so that today the Coast and Geodetic Survey performs a wide variety of essential services for the advancement of marine, aviation, commercial, and industrial interests of the country. It surveys the coasts of the United States and its possessions to insure the safe navigation of coastal and intracoastal waters; it determines geographical positions and elevations in the interior of the country to coordinate the coastal surveys and provide the framework for mapping and other engineering work; it makes observations of tides and currents to furnish datum planes to engineers and tide and current tables to mariners; it compiles and publishes nautical and aeronautical charts to meet the needs of marine and air navigation; it makes observations of the earth's magnetism in all parts of the country to furnish magnetic information essential to the navigator, aviator, land surveyor, and others; and it makes seismological observations and investigations to supply data required in designing structures to reduce the earthquake hazard.

The Bureau is primarily a field organization administered from Washington where the basic field data are received and processed and the results made available to governmental agencies and to the public in the form of maps, charts, and technical publications.

The normal functions of the Bureau play an important part in the protection of life and property at sea and in the air. Its activities are further aimed to meet the public needs involved in large peacetime projects for the multiple use of waters in our main river basins and for acceleration of the national mapping program.

Field Surveys During Year

During the year we extended hydrographic and topographic surveys along the Atlantic, Gulf, and Pacific coasts to furnish essential data for modernizing our nautical charts so that they may better serve the mariner using the new navigational methods and equipment.

In the interior of the country, the basic geodetic network was extended to provide control for the planning and construction phases of large-scale engineering projects. One of the major activities during the past year was the continuation of triangulation and leveling surveys in the Missouri River basin for studies in connection with flood control and reclamation projects. The control work is being planned to correlate with the topographic mapping of the country so as to provide at the earliest possible date the maps that are needed to complete the inventory of our natural resources and to plan and execute the activities of our Nation. Requests for control surveys from civil agencies have far exceeded the facilities available for this work, and only those projects of the highest priority could be undertaken.

In Alaska, coastal surveys and interior control surveys were continued. One survey ship, which means one-fourth of the major survey ships in this area, has been laid up and inactive. Because of the short working season all available facilities should be operated to produce a well-balanced program of surveys in this vast territory.

Alaska is our northernmost outpost. Its growing strategic importance and its potential resources require that full knowledge be had of its vast terrain and surrounding waters. This can only be achieved through comprehensive surveys from which adequate maps and charts can be prepared. This work should not be delayed. Survey work in Alaska is at best a slow and difficult process. Much of the work is in isolated regions and each party must operate as an expedition. Ice conditions and low temperatures add to the difficulties. It is a pioneering undertaking which will entail many hardships and a number of years of patient endeavor.

CHART PRODUCTION AND DISTRIBUTION

Charting Our Coastal Waters

The nautical chart is one of the principal products of the Bureau's activities. Designed to facilitate water-borne commerce, the nautical chart must present a picture of conditions as they exist—a faithful delineation of the ocean floor; navigational aids and channels located with maximum accuracy; and all dangers, such as rocks, reefs, and shoals, clearly depicted.

In the early days of the Bureau's history comparatively few charts were needed to cover the limited areas traversed by the mariner. Today it is necessary to provide charts that will enable ships to reach all potential sources of a greatly expanded commerce. The perfection and general use of modern navigational instruments have called for more detailed information on nautical charts. In addition, the needs of the yachting and pleasure-craft fraternity, which includes a large cross section of the public, have to be met by extending existing charts to facilitate small-boat navigation of rivers and bays. Special charts are provided for the navigation of our intracoastal waterways.

Nautical charts are compiled from the basic field surveys of the Bureau, supplemented by data from other organizations, especially data relating to channel and harbor improvements and changes in aids to navigation. The information shown on charts must be kept up to date. Changes are constantly taking place along our coasts due to the forces of nature and the works of man. Ocean waves and currents are moving sand and mud from one place to another and shifting channels and sand bars. Millions of dollars are being spent annually on harbor improvements and port facilities. Revised editions of charts must be issued when sufficient changes have occurred to make the existing chart hazardous for use. Frequently these changes are so drastic that reconstruction of a chart is necessary.

These unstable features, together with the continued expansion of areas served by water-borne commerce, make the charting of our waterways a never-ending process. A constant alertness is required to the potential needs of our merchant marine, navy, and yachtsmen, to insure that the basic instrument of navigation—the nautical chart—is available and dependable for their use.

Charting Our Airways

The aeronautical chart is a relatively modern requirement. The first chart prepared especially for air navigation was compiled in 1921. Federal responsibility for charting our airways was affirmed in the passage of the Air Commerce Act of 1926. Because of the basic similarity between marine and air charting, the Bureau was assigned the task of preparing and publishing aeronautical charts for civil aviation.

The sectional aeronautical chart series completed by this Bureau in 1935 constituted the first complete chart coverage of the United States on a uniform scale.

Aeronautical charts are compiled from the basic survey material of the Bureau, supplemented by the best topographic information from more than 50 sources. Only that part of the material is selected for charting as will be of assistance to the aviator in obtaining a clear picture of the terrain over which he is flying. In addition to special colors for aeronautical information and water areas, gradient tints are used to emphasize elevations. All landing areas, aids to navigation, and landmarks are indicated for quick identification.

When facilities are available, charts are flight-checked, before final publication, by an experienced observer and details on the chart compared with actual ground features. The flight-check not only insures the incorporation in the chart of latest changes, but it also gives the compiler the airman's view of what should be emphasized on the chart.

Because of the frequent revision of aeronautical charts, the cost to the aviator is kept to a minimum so that frequent replacements will keep him advised of current information without undue expense. Users are informed of the current editions of charts by notices published at 2-week intervals.

Developments in air navigational techniques and changes in information shown on aeronautical charts require continued revisions and additions to the information shown on existing charts and the addition of specialized types of charts for use with newly developed

aids and navigation facilities. Navigation of modern, long-range aircraft flying at greater speeds and higher altitudes has required the development of a special type of chart. The installation of high-frequency ranges throughout the United States will require another special type of chart that at present is in the experimental stage. Special charts must also be provided to simplify air traffic control problems at congested air terminals.

Nautical Chart Production

Modernization of nautical charts has been necessitated partly to modify them for use with new navigational methods, partly for the sake of economy, and partly to take advantage of new reproduction methods.

During the fiscal year 1949, some progress was made in the Bureau's program of reconstruction and modernization of its charts, but there still remains a backlog of revision data which must be applied to the charts.

At the end of the year, 907 nautical charts were on issue. This is an increase of 10 over the previous year. To produce the 816,759 copies distributed, 467 printings were necessary, as follows: 12 new charts, 23 new editions, 398 new prints, and 34 reprints.

Nearly 8,000,000 hand corrections were necessary to correct the charts to date of issue. Several thousand hand corrections will be eliminated annually in the future by an agreement reached between the Coast and Geodetic Survey, the Corps of Engineers, and the Coast Guard, whereby the Light List, the Engineers' weekly reports, and the Bureau's nautical charts will all use the same nomenclature with respect to channels and ranges in the Columbia and Willamette Rivers. Dangers requiring hand corrections were reported to the Coast Guard and the Hydrographic Office for publication in the weekly Notice to Mariners.

The charting of the Gulf Intracoastal Waterway, from Carrabelle, Fla., to the Mexican border, on a new large-scale series was almost half completed at the end of the year. Four new charts were published during the year, bringing the total published to 15. These furnish detailed coverage of the waterway from Carrabelle, Fla., to Houma, La., a distance of about 379 nautical miles. This, together with the fact that all 1,076 miles of the waterway are completely dredged, has greatly increased the demand for completion of the remaining 18 charts. The entire waterway, with a designed depth of 12 feet, but an actual depth of 14 feet, and a bottom width of 125 feet, is intended for use of barge tows and other light-draft vessels not adapted to navigating long stretches of open ocean and gulf waters. The Corpus Christi-Brownsville section is without obstructions.

To supplement the two existing small-scale charts for use with the Loran system of navigation now covering the entire Atlantic coast, one new Loran general chart of similar type, but on a larger scale, was published to meet the needs of the large fishing fleet operating out of Boston and Gloucester. During the latter part of the year, in answer to numerous requests, chart compilation was started on applying Loran curves to the existing larger-scale coast charts. This is

in line with the program of extending the Atlantic coast coverage to include in-shore and coastwise navigation.

A new nautical chart covering the Willamette River from Portland to Walnut Eddy, Oreg., the first of a series of two new charts designed to cover the Willamette River from Portland to Newberg, was published during the year. This chart provides large-scale coverage which is essential to safe navigation of the heavy river traffic and should also be of special use to small-boat owners who navigate the waterway.

A new sailing chart covering the Pacific coast from Cape Blanco to Cape Flattery was also published during the year. This chart completes the series of three designed for offshore navigation along the Pacific coast. Many submarine features are shown in detail which should prove valuable for the determination of position by echo sounding.

Another new chart covers the south coast of Alaska, from Cross Sound to Yakutat Bay. This chart was designed in response to requests from the fishing industry for a chart covering the fishing banks of this part of the Gulf of Alaska. Other new charts published during the year cover Agattu Island, and Alaid and Nizki Islands, in the Aleutians; and Winter Harbor and Belfast Harbor in Maine.

In the field of related nautical chart publications, the Bureau publishes a series of Coast Pilots to supplement the information shown on the charts. Each Pilot is based on intensive field examination. During the year, field inspection was completed for revision of the Gulf Coast Pilot. Inspection was also begun for revisions of the Atlantic Coast Pilot, sections A and B, and the Hawaiian Islands Coast Pilot.

Aeronautical Chart Production

At the end of the fiscal year, 905 aeronautical charts were being maintained by the Bureau. These include 265 standard aeronautical charts, 552 instrument approach and landing charts (including 77 instrument landing system charts), and 88 radio facility charts. The following new charts were compiled and published: 1 local, 88 radio facility, 33 instrument landing system, and 38 instrument approach and landing.

During the year the schedule for printing the standard aeronautical charts of the United States was revised to effect better coordination with Civil Aeronautics Administration airport inspections.

A new series of radio facility charts of the United States was prepared and published to replace the former series of 45 charts. This provides coverage on a larger and uniform scale. The continuing increase in navigational radio aids requires the larger scale for increased clarity. The new series also includes six danger area charts, an index and tabulation of "omni" facilities, two nonstandard holding pattern charts, one holding chart, one coded departure route chart, the civil airway and mileage chart, and three additional sheets of miscellaneous information.

The danger area charts show areas of the United States hazardous to air navigation. Danger areas are shown graphically in relation to the airways and each area is numbered to correspond to a tabulation

on the back of the chart which defines the type of hazard characterizing the area, such as "Caution," "Danger," or "Warning"; activity of the area, such as bombing and gunnery practice; maximum altitude of hazardous area; and hours of operation. The danger area charts are published and distributed as a part of the radio facility chart series.

The installation and commissioning of omni facilities in the United States required the publication of an omni index map and tabulation. Several experimental printings have been issued through the CAA for operational testing of these facilities. Route chart 2201, Chicago to Gander, was overprinted with special omni symbols and a new experimental chart, designated OM–1, covering the Chicago to New York VOR airway, was published. This was the first chart made available with complete omni information in conjunction with the associated low-frequency facilities. The development of a new series of charts in cooperation with the CAA is now under way. These charts will contain all information necessary for navigation and air traffic control with omni facilities.

In cooperation with the CAA, the Bureau developed two charts to simplify air traffic control problems for holding and departure at major air terminals. A holding chart for LaGuardia Airport, New York, was distributed by the CAA for experimental use and illustrates graphically the holding patterns for this airport. A coded departure route chart for LaGuardia and Newark Airports was published and will be utilized by the New York Air Traffic Control Center to simplify clearance phraseology and to indicate routes prescribed for flights departing from LaGuardia and Newark Airports. Operational experience with these two charts will materially aid in the production of additional charts of this type planned for next year. Both types of charts will be issued automatically to subscribers of radio facility charts and may be purchased separately.

At the request of the CAA, the Bureau undertook the construction of a planimetric map of Indianapolis, Ind., on a scale of 1 : 125,000. The map, to be printed in four sections, will be used for testing navigational facilities. Two of the sections have been delivered to the CAA and the remaining two will be made available early next year.

The Bureau is developing an instrument approach and landing chart that depicts approved procedures for use with ADF (automatic direction finding) stations. These charts should be available early next year for all fields with approved procedures.

Due to expanding civil air activity, a new series of 14 radio facility charts of Alaska was published.

Chart Distribution

Nautical and aeronautical charts are sold to the public from the Washington office, through field offices, and through authorized agents located in major cities in the United States, Alaska, Canada, Hawaii, the Philippines, the West Indies, and Europe. Chart distribution centers, to supply charts to the agents in their areas, are maintained at New York, Baltimore, Kansas City, Los Angeles, and San Francisco.

These centers are able to furnish more efficient service to the authorized agents and permit the agents to maintain smaller inventories. Informational pamphlets which furnish the dates of latest prints of each series of aeronautical charts are revised and published periodically and furnished to all agents and to the public, in an effort to discourage the use of obsolete charts.

The Bureau continued to act as a distributing agency for the Aeronautical Chart Service of the Department of the Air Force. Permission was granted to authorized agents to stock foreign aeronautical charts and to issue them in accordance with the Aeronautical Chart Service directive. A total of 1,269,271 foreign and special aeronautical charts were issued.

The service of filling all requests with the biweekly list of latest prints was continued, and it is felt that, due to this information, charts were more frequently purchased with resulting increased safety to the aviator.

Twenty-four additional nautical chart agents were appointed and 9 canceled during the year, bringing the total number to 215. Inspections were made of 153 agencies.

Sixty new authorized agents for aeronautical charts were appointed and 71 canceled, making a total of 395 agents under contract with the Bureau. A total of 317 were inspected, and 20 were given an additional inspection. The expense of these inspections has been more than justified by the marked increase in efficiency of the agencies inspected.

The following table shows the number of charts and related publications issued during the past 4 years:

Charts and related publications issued

Type of chart or publication	1946	1947	1948	1949
Nautical charts	2,235,396	1,225,639	1,178,346	816,759
Aeronautical charts	9,097,817	7,988,426	6,581,130	7,077,366
Airport and radio facility charts	2,705,446	4,885,703	6,533,924	9,260,048
Coast pilots	14,067	15,993	17,171	20,541
Tide tables	80,014	65,767	43,481	55,137
Current tables	37,856	45,778	39,051	32,687

The distribution of nautical and aeronautical charts during the year was as follows:

Distribution of nautical and aeronautical charts in 1949

NAUTICAL			
Free issue:		*Percent*	
Department of the Navy	333,128	40.8	
Coast Guard	6,587	.8	
Department of the Army	9,172	1.1	
Coast and Geodetic Survey	11,929	1.5	
Other departments	8,003	1.0	
	368,819	45.2	
Sales	359,231	44.0	
Condemned	88,709	10.8	
	816,759	100.0	816,759

Distribution of nautical and aeronautical charts in 1949—Continued

		Percent	
UNITED STATES AERONAUTICAL			
Free issue:			
Department of the Air Force	3, 803, 682	53. 7	
Department of the Army	40, 850	. 6	
Department of the Navy	782, 092	11. 0	
Civil Aeronautics	43, 635	. 6	
Coast and Geodetic Survey	47, 799	. 7	
Other departments	14, 986	. 2	
	4, 733, 044	66. 8	
Sales	1, 518, 926	21. 6	
Condemned	825, 396	11. 6	
	7, 077, 366	100. 0	7, 077, 366
UNITED STATES AIRPORT AND RADIO FACILITY			
Total issue			9, 260, 048
SPECIAL AND FOREIGN AERONAUTICAL			
Total issue			1, 269, 271
Total			18, 423, 444

SURVEYS OF COASTAL WATERS

Coastal surveys, embracing hydrography, topography, and coastal triangulation, furnish the basic data essential in the production of nautical and aeronautical charts. These surveys are accomplished by ships and shore-based parties operating along the coasts of the United States and possessions, including inland waterways, to procure information pertaining to shore line, locations of channels, characteristics of the sea bottom, positions of reefs, shoals, and other dangers to navigation, and many other features along the coasts. Approximately 90,000 statute miles of tidal shore line, fringed by over a million square miles of coastal waters, covering the continental United States, Alaska, Hawaiian Islands, Guam, Puerto Rico, Canal Zone, and Virgin Islands, are under the jurisdiction of the Coast and Geodetic Survey for coastal surveys.

To safeguard our coastal waters for navigation, periodic resurveys are made. In many areas these are required because of changes taking place in shore line and ocean bottom as a result of natural and artificial causes. Other areas, though unchangeable, must be resurveyed to modernize older charts which lack the extent of detail which the navigator presently needs for use with improved navigational devices. The problem of surveying our coastal waters is, therefore, a continuing one.

During the year, surveys were carried on under the normal peacetime program into areas of importance to commercial shipping and undeveloped regions containing oil, fishing, and mining resources, and were also extended into areas of strategic importance at the request of the armed services.

Seventeen ships and 3 shore-based parties were engaged on coastal surveys along the Atlantic, Gulf, and Pacific coasts of the United

States, and in Alaska. One ship was engaged in hydrographic surveys in the Philippine Islands. A summary of the surveys accomplished during the year is given in the following table:

Statistical summary of coastal surveys

Locality	Hydrography				Topography		Triangulation		
	Sounding lines	Area	Wire drag	Area	Shore line	Area	Length of schemes	Area	Geographic positions
	Miles	*Square miles*	*Miles*	*Square miles*	*Miles*	*Square miles*	*Miles*	*Square miles*	*Number*
Coast of Maine	842	25							
Massachusetts to Cape Charles	6,478	342	272	110			3	6	12
Chesapeake Bay	3,426	96			28	3	2	56	35
Gulf Coast	12,206	6,444							
California and Oregon	2,120	92			23		12	40	37
Lake Pend Oreille, Idaho, and Lake Franklin D. Roosevelt, Washington	3,936	108			74	88	3	5	10
Alaska	32,916	22,585			400	101	375	1,656	601
Philippine Islands	1,609	46	129	9	36	28	28	73	71
Total	63,533	29,738	401	119	561	220	423	1,845	706

Along the Atlantic and Gulf coasts, the survey ships *Cowie*, *Gilbert*, *Hilgard*, *Wainwright*, *Parker*, *Bowen*, *Stirni*, *Hydrographer*, and *Sosbee* accomplished hydrographic, wire-drag, current, or coast pilot surveys.

The *Cowie* completed hydrographic surveys and a current survey in the James River, Va., and commenced combined operations in Tangier Sound, Md.

The *Gilbert* completed basic hydrographic surveys in Point Judith Pond and Harbor of Refuge, R. I., and in Winter Harbor and approaches, Maine. Combined operations were later begun in the vicinity of Marshall Island, Maine.

The *Hilgard* and *Wainwright*, operating as a unit, conducted hydrographic and wire-drag surveys in the vicinity of Boston Harbor, Mass. Wire-drag investigations were made in the approach to Black Rock Channel, Mass., and in the vicinity of Brenton Reef Lightship and Point Judith, R. I. Measured-mile courses in the vicinities of Sandy Hook, N. J., and Sheffield Island Harbor, Conn., were established by the *Hilgard*, after which field work on the revision of the Atlantic Coast Pilot, section B, was begun. Toward the end of the fiscal year, the *Wainwright* commenced hydrographic operations in Hempstead Bay, Long Island.

The *Parker*, *Bowen*, and *Stirni*, operating as a unit, continued both visual and Shoran-controlled wire-drag investigations and hydrography along the coasts of Maryland and Virginia to locate sunken wrecks. At the request of the Department of the Navy, a special survey in the vicinity of Bloodsworth Island, Md., was completed. A special survey of Nandua Creek, Va., was also completed.

The *Hydrographer* continued with hydrographic surveys in the Gulf of Mexico, using the specially designed electronic position indicator. The maximum range recorded with this equipment was 289.6 nautical miles.

The *Sosbee* completed coast pilot revision work through the Morgan City-Plaquemine Inland Waterway, in the Mississippi River from Baton Rouge to New Orleans, along the coast of Texas, and through all navigable waterways from and including Galveston Bay to the Rio Grande River. The ship was later engaged on a current survey in Tampa Bay, Fla.

On the Pacific coast and in Alaska the survey ships *Bowie*, *Hodgson*, *Explorer*, *Pioneer*, *Pathfinder*, *Derickson*, *Patton*, and *Lester Jones* were engaged on combined operations. The *Surveyor* remained in Seattle, Wash., on an inactive status, with reduced complement, because of insufficient operating funds.

The *Bowie* carried on combined operations in the San Francisco Bay and Carquinez Strait areas. Special hydrographic surveys, requested by the Department of the Navy, were completed in the vicinity of the Golden Gate and the San Francisco Bay water front from Anita Rock to North Point.

The *Hodgson* continued hydrographic surveys in the Columbia and Willamette Rivers, Oreg. Field work in the Columbia River between Bonneville Dam and The Dalles was completed.

The *Explorer* made Shoran-controlled hydrographic surveys in the Aleutian Islands, in the vinicity of Kiska and Amchitka Islands. Field work in the vicinity of Little Kiska Island and along the east coast of Kiska Island westward of South Pass was completed during the year.

The *Pioneer* operated in the Aleutian Islands, in the vicinity of Kiska, Segula, Semisopochnoi, and Little Sitkin Islands, continuing Shoran-controlled hydrographic surveys of the previous year.

The *Pathfinder* performed combined operations in Bristol Bay, Alaska.

The *Derickson*, the former AGS–6 (PCS 1458), continued combined operations in Prince William Sound, Alaska, in the vicinity of Passage Canal, Whittier, and Cordova. On November 23, 1948, the ship was permanently transferred from the United States Navy to the jurisdiction and service of the Coast and Geodetic Survey.

The *Patton* was engaged on combined operations in Olga and Neva Straits, Alaska, between Sitka and Salisbury Sounds, approaches to Neva Strait, and St. John Baptist Bay.

The *Lester Jones* made hydrographic surveys and gave ship support to the triangulation and photogrammetric parties operating in the northwest portion of Bristol Bay. Late in the season work was done in Prince William Sound. Toward the end of the fiscal year, combined operations were commenced in Kukak Bay.

The Arctic shore party continued with combined operations along the Arctic coast of Alaska. These surveys are being made at the request of the Department of the Navy.

At the close of the Alaska work, the ships *Explorer*, *Pioneer*, and *Pathfinder* ran deep-sea sounding lines in the North Pacific Ocean from the Aleutian Islands to points on the west coast of the United States, as part of the program of running sounding lines by Survey vessels while en route from their working grounds. One line extended from the vicinity of Adak to Yaquina Head, Oreg., thence to the Strait of Juan de Fuca; another line was run from Adak to Point Arena, Calif.; and another from the vicinity of Unimak Pass to the

Columbia River Lightship, thence to Cape Flattery. A new seamount, about a mile high, with a least depth of 460 fathoms, was discovered in latitude 51° N., longitude 143° W.

A shore-based party completed basic hydrographic surveys in Pend Oreille Lake, Idaho, requested by the Department of the Navy.

Another shore-based party continued basic hydrographic surveys in Lake Franklin D. Roosevelt, Washington. This is being done at the request of the Bureau of Reclamation for a survey from Coulee Dam upstream to the international boundary.

In the Republic of the Philippines, the Manila office of the Bureau, under the direction of the Director of Coast Surveys of the Philippine Islands, continued survey work and training of Filipinos, and assisted in the organization of the Philippine Bureau of Coast and Geodetic Survey, authorized by the Philippine Rehabilitation program. Three commissioned officers and five civilian employees were on duty in the Manila office to assist in field operations, revision of charts, and training. The ship *Tulip* completed combined operations in the Manila Harbor area and commenced a revision hydrographic survey in Cebu Harbor and approaches. The ship *Hornet* was commissioned and upon completion of necessary repairs will undertake detached surveys. Funds for carrying on the program, with the exception of the pay of commissioned officers, were transferred from the Department of State.

District offices were maintained during the year at the following ports: Boston; New York; Norfolk; New Orleans; Los Angeles; San Francisco; Portland, Oreg.; Seattle; and Honolulu. These offices rendered valuable service in supplying information for the correction of charts, in assisting the field parties of the Bureau in obtaining supplies and personnel, in planning field work of the parties working in their respective districts, and in disseminating nautical and engineering data in response to requests from public and official sources.

Processing offices were continued at the two principal bases of the field parties, Norfolk and Seattle. These offices process field records, plot hydrographic surveys, and perform other work in connection with the survey records. The operation of these field offices expedites the application of field surveys to the finished nautical charts and permits close cooperation between the field engineer and the office cartographer.

PHOTOGRAMMETRIC SURVEYS

Accurate detailed surveys of the coastline and the land area immediately adjacent thereto are essential to the production and maintenance of nautical charts; consequently, since its inception, the Bureau has been engaged in mapping the coastline. Today most of this mapping is done by photogrammetric methods involving the use of aerial photographs. The resulting topographic maps add to the topographic map coverage of the United States and its possessions, and, in addition to providing the information required for nautical charts, they provide data for engineering construction, road building, and other private and public work which requires a comprehensive knowledge of the land. The photographs from which the topographic maps are compiled are also extremely useful to Government and private

agencies for planning in advance of the completion of the maps and for the detailed information contained on the photographs that cannot all be transferred to maps.

The use of aerial photographs started in the Bureau in 1922 and has continued on an increasing scale with great improvements in the quality and efficiency of coastal mapping. The use of photographs does not eliminate the need for ground surveys which provide control and accurate interpretation of photographic detail. Ground surveys account for approximately one-half of the total cost of coastal mapping. The main work phases in map production from aerial photographs are: Aerial photography, laboratory processing of photographs, supplemental ground surveys and field inspection, office compilation, field edit, office review and drafting, and publication.

For the most part, aerial photographs have been taken by Bureau personnel operating in cooperation with the United States Coast Guard, which furnishes the airplane and flight crew. The areas photographed during the year were: Kennebec River, Maine; parts of New York Harbor; Pamlico Sound and New River, N. C.; Daytona Beach and Jacksonville, Fla.; Corpus Christi to Brownsville, Tex.; Puget Sound; various small areas on the Atlantic and Pacific coasts for chart revisions; and, in Alaska, coastal areas at Anchorage, Prince William Sound, Bristol Bay, Kuskokwim Bay, Norton Sound, Seward Peninsula, the Arctic coast southwest of Point Barrow, and the Aleutian Islands.

During the year, photogrammetric field surveys were in progress or were completed in the following areas: Eastern Maine; Elizabeth Island, Martha's Vineyard, and Nantucket Island, Mass.; Fishers Island, Conn.; Pamlico Sound, N. C.; east coast of Florida in the vicinity of Cape Canaveral; the Louisiana coast in the vicinity of Abbeville; the Texas coast in the vicinity of Corpus Christi; and, in Alaska, in Bristol Bay, Kuskokwim Bay, and Kotzebue Sound.

Field work preliminary to topographic mapping by stereoscopic instruments was continued by ships of the Bureau in the Aleutian Islands in conjunction with hydrographic surveys, at the specific request of the Department of the Army and by mutual agreement with the Geological Survey.

At the close of the year field inspection preliminary to compilation was being done by photogrammetric personnel attached to triangulation parties on the Yukon and Kuskokwim Rivers and along the north shore of the Seward Peninsula. Data obtained are to be turned over to the Army Map Service for compilation.

The establishment of the photogrammetric test area near McClure, Ohio, has provided the means for improving the accuracy and reliability of nine-lens photographs and for a more accurate and facile calibration of the nine-lens camera and its associated equipment. Many other Government mapping agencies, research organizations, universities, and photogrammetric companies are using this test area for various studies which will lead to improved photogrammetric techniques and results.

Photogrammetric offices continued in operation in Baltimore, Md.; Tampa, Fla.; and Portland, Oreg.; compiling topographic and planimetric maps of coastal areas in eastern Maine; Connecticut River; Hempstead Bay; Delaware River; Pamlico Sound; Florida east coast;

Louisiana coast; Humboldt Bay; Coos Bay; Williamette and Columbia Rivers; and Bristol Bay, Alaska Peninsula, St. Matthew Island, and the Aleutian Islands.

In the Washington office, the compilation, reviewing, and drafting of planimetric and topographic maps prior to publication were continued. Major projects included shoreline surveys of the Gulf Intracoastal Waterway; Pend Oreille Lake, Idaho; Arctic coast east of Point Barrow; and Sitka Sound; stereoscopic mapping on the Delaware River; Tidewater, Va.; Alaska Peninsula; Nushagak Peninsula; and in the Aleutian Islands; and the preparation of reconnaissance mosaics on the Alaska Peninsula and the Arctic coast.

Seven airport survey parties operated throughout the United States during the fiscal year and completed surveys at 137 airports. These surveys are used in the production and maintenance of aeronautical instrument approach and landing charts and airport obstruction plans.

One hundred and three airport obstruction plans were published during the year, bringing the total published to date to 301. This is part of a program for obstruction plans for some 550 airports requested by the Civil Aeronautics Administration. The plans are used by that agency in administering regulations regarding the allowable pay load of various types of aircraft.

Demands from the general public and other Federal agencies for copies of aerial photographs continue to maintain a large work load and strain on facilities of the air photographic laboratory. At times official requests have been so heavy that outside orders have been quoted on a 1- to 2-month delivery basis. A second transforming printer for the nine-lens films is now under construction and is expected to relieve this condition.

A summary of the photogrammetric mapping of coastal areas for the fiscal year 1949 is given in the following tabulation:

Summary of photogrammetric mapping

Locality	Aerial photography	Photogrammetric field surveys				Compilations completed				Planimetric maps published	
		Shoreline	Interior area	Contours (plane-table)	Contours (stereoscopic)	Planimetric maps and shoreline surveys		Topographic maps [1]			
	Square miles	*Miles*	*Square miles*	*Square miles*	*Square miles*	*Square miles*	*Number*	*Square miles*	*Number*	*Square miles*	*Number*
Maine (Portland to Canadian boundary)	160					140	7	290	11	300	12
New York (Hempstead Bay, Long Island)						310	8				
Long Island Sound		414	40			158	10				
New York (miscellaneous areas for chart corrections)	35										
Maryland and Virginia (miscellaneous areas for chart corrections)	125										
Virginia								105	2		
Delaware River						70	5	95			
North Carolina	75	440	772	630		30	1	490	17		
Florida (East coast)	400	422	614	647				569	16		
Florida (West coast)		70				70	6				
Louisiana		280	731	654		356	7				
Louisiana and Texas (Intracoastal Waterway)						200	40				
Texas		404	654	40							
California, San Francisco Bay										234	9
California, Humboldt Bay						45	5				
Oregon, Coquille River, Umpqua River, and Coos Bay		140				9	1				
Willamette River										28	1
Columbia River	500					80	5				
Washington, Bellingham	900										
Alaska:											
Prince William Sound	1,700										
Alaska Peninsula		595	2,030			1,750	25				
Aleutian Islands	773	60	50		50			50	9		
Bristol Bay	4,600	130	1,300		100	1,625		100	3		
Norton Sound	1,000										
Seward Peninsula	1,150										
Kotzebue Sound		375	2,500								
Arctic coast	1,700	40	100			200	5				
Totals	13,118	3,370	8,791	1,971	150	5,043	125	1,699	58	562	22

[1] Surveyed and compiled by the Coast and Geodetic Survey and published as quadrangles by the Geological Survey.

GEODETIC CONTROL SURVEYS

Geodetic control surveys consist of the determination of precise latitude, longitude, and azimuth for marked points and prominent natural and artificial objects, and the determination of the elevations above sea level for bench marks. Geodetic control surveys are related to the ellipsoidal figure of the earth and are the most accurate type of land surveys made. All points in the geodetic network of horizontal control are referred to the same horizontal datum—the North American 1927 datum—and are therefore correctly related in position with respect to each other, no matter how far apart they may be. The precise leveling is referred to the datum of mean sea level and all elevations of bench marks determined on these surveys are correctly related in elevation to each other.

Geodetic control surveys are necessary for the mapping and charting programs of the United States. They are used extensively in the planning and construction phases of large-scale engineering projects such as those for flood control, irrigation, navigation, water supply, and drainage; and for highways, railroads, tunnels, canals, airports, and similar projects.

During the war there was a military requirement for these surveys and, supported by transfer of funds, the work was accelerated. Since the war, the military demand was replaced by the requirements of civil agencies. Requests for control surveys have far exceeded the allotment made available for this work, and only those projects of the highest priority can be accomplished. This often results in a postponement of the work in important areas, with subsequent uneconomical effect on the program of other agencies.

One of the major activities during the past year was the continuation of triangulation and leveling surveys in the Missouri River Basin for studies in connection with flood control and reclamation projects. Four triangulation parties, two reconnaissance parties, and three leveling units operated in Montana, North Dakota, South Dakota, Nebraska, Missouri, Kansas, and Iowa. Along the Missouri River, specific appurtenances of the Corps of Engineers pertaining to remedial measures for flood control were located. Retrogression ranges on the banks of the river were located and referred to the national network of control. In the immediate vicinity of the dam sites, detailed control was established to provide data for the construction surveys.

Control surveys were carried on in Wyoming, Colorado, western Arizona, and southern California for the Bureau of Reclamation; and in Indiana, Kentucky, North Carolina, Texas, Mississippi, northern California, Oregon, and Washington for the mapping program of the United States Geological Survey.

An astronomic party operated in various parts of the country for the determination of latitude, longitude, and azimuth in connection with the adjustment of the basic control network.

The variation of latitude observatories at Ukiah, Calif., and Gaithersburg, Md., continued in uninterrupted operation throughout the year. The data from these observatories are sent to the central office in Italy for computation and comparison with similar observations from observatories established on the same parallel of latitude in Japan, Italy, and the U. S. S. R.

A major project during the year was the continuation of geodetic surveys in western Alaska. Four parties, of 30 men each, are operating along the Bering Sea coast from Port Heiden, Alaska Peninsula, to the north shore of the Seward Peninsula. These parties are working in isolated regions and must operate as an expedition. One of the difficult problems encountered is to ensure that necessary supplies and replacements are on hand when needed. Transportation for these parties is being furnished by wheel and float planes, helicopters, weasels, and small boats. The expenses of three of these parties are being financed from funds transferred to the Bureau by the National Military Establishment.

Triangulation work was continued on the Island of Hawaii for the determination of geographic positions. The territorial surveyor is cooperating with this project and is furnishing some of the personnel and assumes about 50 percent of the cost.

A gravity meter was operated continuously at the base station in the Department of Commerce Building in Washington, D. C., for a period of 15 days in May 1949 with readings recorded at intervals of 15 minutes. These observations were part of a world-wide series of continuous observations made by various countries and industrial concerns to determine the tidal effect on gravity.

A gravity party operated in South America. Observations were made with a pendulum gravity apparatus and a Worden gravimeter. Nine pendulum gravity stations were established in Latin America.

At the request of several of the Federal agencies and with funds allocated from those agencies, the following special surveys were accomplished:

For the Department of the Army, control stations were established at the Ordnance Depot at Aberdeen, Md., and surveys were made in the vicinity of Tooele, Utah, for an experimental project to determine the effect of various types of explosives on underground structures built in different types of soil.

Triangulation and leveling were accomplished for the Department of the Navy at the Aviation Ordnance Test Station in the vicinity of Chincoteague, Va., and triangulation and traverse surveys were made at the Naval Test Area in the vicinity of Inyokern, Calif. Locations were also provided for four photo-theodolites at the Chesapeake Bay Annex of the Naval Research Laboratory.

At the request of the Public Buildings Administration, a number of bench marks were set in the exterior walls of the White House at Washington, D. C. Periodic leveling will be accomplished to these marks during the period of alterations to the White House to determine if any settlement of the foundation is occurring. The verticality of the side walls is also being determined and will be tested at periodic intervals during the construction work. The movement of several types of piles under various loadings was also determined at the proposed location of the General Accounting Office building in Washington, D. C.

Several special projects were undertaken or continued during the year. In connection with an experimental project to determine whether the deflection of the vertical can be obtained from a study of gravity anomalies, which is being carried on in cooperation with the United States Army Map Service, a gravity party operated in the south-central section of the country. Observations were made with

a pendulum gravity apparatus and a Worden gravimeter. Thirty-six pendulum gravity stations were established in the United States. Gravimetric deflections were obtained at seven astronomic-geodetic points, the radius of gravity field varying from 130 to 180 kilometers from the station. A considerable amount of additional gravity data have been obtained from commercial sources on a confidential basis, providing increased regional coverage and detailed surveys at several additional astronomic-geodetic stations. The project has included studies of such problems as departure from normal vertical gradient, reduction of astronomic observations to the geoid, and obtaining adequate gravity representation in mountainous areas.

Two parties operated in southern California on earthquake investigation surveys. The program is to provide periodic surveys across fault lines in an attempt to determine any movement which might possibly be a forecast of an earthquake preliminary to a major break.

Leveling, triangulation, and traverse were accomplished in the vicinity of Terminal Island, Long Beach, Calif., in connection with determinations of subsidence and horizontal movement in this area which are affecting the large installations of the Bureau of Yards and Docks of the Navy. Periodic leveling and traverse surveys will be accomplished here in order to determine the extent of the vertical and horizontal movements.

At the request of the Nevada State Planning Board, triangulation surveys were accomplished north of Elko, Nev. The State Planning Board and the State Highway Department of Nevada are desirous of having an extensive amount of control established in their State.

At the request of the Highway Department of the Commonwealth of Virginia, and with funds from that organization, triangulation was provided in connection with construction of the York River Bridge at Yorktown, Va.

The field activities during the year are summarized in the following tables:

First-order base-line measurement

Locality	Length	Locality	Length
	Miles		*Miles*
Platinum, Alaska	4.3	Lufkin, Tex	2.9
Charlton, Mo	4.2	Yorktown, Va	1.0
Kincaid, Kans	5.6	Waimea, Hawaii	2.2
Rail, Wyo	3.9	Keei, Hawaii	2.1
Caballo-Scorpion, Calif	3.5	Kahuku, Hawaii	3.3
Valparaiso, Ind	7.0	Hardin, Mo	6.0
China Lake, Calif	13.4	Winifred, Mont	6.4
Normal, Calif	1.2	Bethel, Alaska	1.0
Poplar, Mont	8.0	Aberdeen, Md	2.5
Sun Prairie, Mont	5.9	Shishmaref, Alaska	4.4
Sinclair, Wyo	5.1	Chinco, Va	6.0
Sego, Calif	4.2		
Kofa, Ariz	6.0	Total	110.1

Area triangulation—first- and second-order

	Number of stations	Length of scheme	Area
		Miles	*Square miles*
Bismarck to Driscoll, N. D.	9	25	450
Douglas-Casper area, Wyo.	63	60	3,090
Orr to Namakan Lake, Minn.	8	35	560
Missouri River, Yankton to Pierre, S. D.	117	190	2,980
Vicinity of Inyokern, Calif.	25	40	570
Osage River area, Kans.	146	75	3,745
Alexandria to N. Manchester, Ind.	110	90	1,405
Michigan City to LaFayette, Ind.	142	130	1,695
Modoc and Fremont National Forests, Calif. and Oreg.	174	150	6,215
Bristol Bay to Kuskokwim Bay, Alaska	92	155	2,045
Rawlins-Laramie area, Wyo.	90	110	3,830
Missouri River, Bainville to Fort Peck, Mont.	98	155	2,015
Charitan River area, Mo.	108	120	3,190
Grand River area, Mo.	101	100	2,920
Missouri River, Fort Peck to Leedy to Winifred, Mont.	79	135	1,690
Charleston, Nev. to Glenns Ferry, Idaho	40	90	1,080
Susanville, Calif. to Klamath Falls, Oreg.	201	145	8,980
Trinity River area, Tex.	127	150	2,430
Hickory-Wilkesboro Area, N. C.	106	80	1,600
Lufkin area, Tex.	124	75	4,130
Vicinity of Gorman, Calif.	4	20	160
Vicinity of Long Beach, Calif.	33	5	10
Liberty-Meadville area, Miss.	100	50	1,950
Raemon to Smithfield, N. C.	81	80	720
Wilson area, N. C.	51	40	870
Vicinity of Yorktown, Va.	6	3	5
Corpus Christi-Kingsville area, Tex.	86	50	1,320
Sarita-Raymondville area, Tex.	6	25	95
Santa Rosa area, Calif.	83	65	2,540
Midland-Ogilby area, Calif. and Parker-Yuma area, Ariz.	173	140	4,520
Beatty area, Nev. and Calif.	40	60	2,450
Aberdeen Proving Ground, Md.	10	10	100
Laramie-Fort Collins area, Wyo.-Colo.	29	105	1,450
Kuskokwim Bay and River, Alaska	22	50	500
Plattsburg-Sedalia area, Mo.	78	45	2,460
Missouri River, Winifred to Great Falls, Mont.	25	60	660
Columbia area, Mo.	85	100	1,910
Plumas National Forest, Calif.	64	140	2,450
Vicinity of Chincoteague, Va.	12	15	90
Morehead-Paintsville area, Ky.	55	60	1,860
Egegik to Port Moller, Alaska	14	45	460
Island of Hawaii, Hawaiian Islands	93	140	980
Yukon River, Alaska	1	10	75
Total	3,111	3,428	82,255

First-order traverse measurement

Locality	Number of stations	Length
		Miles
Vicinity of Inyokern, Calif.	117	14.5
Vicinity of Maricopa, Calif.	222	11.0
Vicinity of Long Beach, Calif.	34	9.5
Vicinity of Brea, Calif.	310	10.0
Total	683	45.0

Reconnaissance

[For area triangulation—first- and second-order]

Locality	Length of scheme	Area
	Miles	*Square miles*
Bismarck to Driscoll, N. D.	25	450
Missouri River, Fort Peck to Sun Prairie, Mont.	70	1,190
Plumas National Forest, Calif.	90	4,990
Jacksmith Bay to Eek River, Alaska	55	385
Blackwater and Grand Rivers area, Mo.	95	6,615
Poplar River area, Mont.	60	2,330
Rawlins, Wyo. to Fort Collins, Colo.	120	8,360
Missouri River, Leedy to Winifred, Mont.	90	900
Lemhi Valley, Idaho	100	1,250
Medicine Lake area, Mont.	55	2,490
Kuskokwim Bay, Alaska	50	475
Vicinity of Inyokern, Calif.	40	570
Davenport-Ritzville area, Wash.	90	5,950
Missouri River, Winifred to Fort Benton, Mont.	70	830
Missouri River, Fort Benton to Great Falls, Mont.	80	1,665
Grand River area, Mo.	70	2,310
Des Moines-Creston area, Iowa	130	5,165
Kotzebue Sound, Alaska	115	2,755
Broadus area, Mont. and Wyo.	170	6,835
Cajon Pass area, Calif.	10	55
Raemon to Smithfield, N. C.	80	720
Wilson area, N. C.	45	1,020
Vicinity of Yorktown, Va.	3	3
Vicinity of Dexter, Mich.	10	55
Corpus Christi-Kingsville area, Tex.	50	1,320
Glamis area, Calif.	50	1,940
Clear Lake area, Calif.	85	4,510
Rocky Mount-Durham area, N. C.	65	1,715
Tyler-Pittsburg-Marshall area, Tex.	105	11,750
Oblique Boundary area, Calif. and Nev.	210	15,755
Raleigh-Greensboro area, N. C.	80	3,040
Morehead-Paintsville area, Ky.	80	3,390
Sarita-Raymondville area, Tex.	65	1,385
Texarkana-Magnolia area, Ark.	70	2,900
Plain Dealing-Haynesville area, La.	50	1,175
Hugo-Clarksville area, Okla. and Tex.	60	3,135
DeQueen-Idabel-New Boston area, Ark., Okla., and Tex.	60	1,960
Millerton to Wilburton, Okla.	60	895
Aberdeen Proving Ground, Md.	10	100
Kuskokwim Bay and River, Alaska	75	825
Bowman, N. D. to Garland, Mont. and Mildred to Powderville, Mont.	210	2,520
Vicinity of Chincoteague, Va.	15	90
Bliss to Duff, Nebr.	60	600
Atkinson-O'Neill area, Nebr.	55	2,200
Big Sioux River area, S. D., and Iowa	60	1,620
Ukiah-Weaverville area, Calif.	160	5,160
Kernville area, Calif.	60	2,640
Egegik to Port Moller, Alaska	75	750
Island of Hawaii, Hawaiian Islands	180	1,500
Yukon River, Alaska	40	560
Total	3,813	131,803

Leveling

State	First-order	Second-order	State	First-order	Second-order
	Miles	*Miles*		*Miles*	*Miles*
Alabama	64	1,146	Montana	62	364
Arizona	232	48	Nebraska	16	107
California	1,067	488	Oregon	0	20
Idaho	4	434	South Dakota	132	164
Iowa	137	319	Tennessee	214	10
Kansas	56	8	Texas	31	749
Kentucky	4	1	Washington	3	61
Louisiana	5	0	Wisconsin	1	102
Michigan	114	1,460	Wyoming	2	26
Minnesota	59	401			
Missouri	361	111	Total	2,564	6,019

Astronomy

State	Determinations			State	Determinations		
	Latitude	Longitude	Azimuth		Latitude	Longitude	Azimuth
Indiana	3	3	[1] 1	Wyoming			1
Kansas	1	1	1	Alaska	1	1	1
Montana			1	Hawaii			2
Texas	1	2		Total	7	8	6
Washington	1	1	[1] 1				

[1] These two azimuths are repeat observations.

Gravity

Location	Determinations	Location	Determinations
Colorado	10	Utah	5
Indiana	2	South and Central America	9
Kansas	5	Previously omitted	3
Kentucky	3	Total	48
Nebraska	7		
Nevada	1		
New Mexico	3		

Summary of geodetic work, June 30, 1949

Work	July 1, 1948 to June 30, 1949	Total to June 30, 1949
	Miles	*Miles*
Triangulation, first- and second-order, length of arc	3,428	110,555
Leveling, first- and second-order	8,583	366,042
	Number	*Number*
First-order base lines	24	348
Second-order base lines	0	56
Latitude stations	7	1,020
Longitude stations	8	824
Azimuth stations	6	1,310
Gravity stations	48	2,050

Processing of field records continued in the offices in Washington and New York City. One hundred and fourteen projects of triangulation or traverse were adjusted, providing data for 6,167 stations distributed in 21 States and in Alaska.

Seven countries of western Europe have submitted their triangulation data to the Army Map Service and the latter has sent them to the Coast and Geodetic Survey. These data will be adjusted simultaneously so that the final results will be on the same European datum. The preliminary computations are under way at the present time.

Eight large triangulation adjustments were completed using the newly installed punch-card computing machines, and 1,200 geographic positions in South Dakota were converted to plane coordinates.

Preliminary computations were made for 1,831 miles of first-order and 2,363 miles of second-order leveling; combination computations were made for 103 miles of second-order leveling; and distribution of corrections were made for 356 miles of first-order and 1,721 miles of

second-order leveling. Eight adjustments were completed requiring the solution of 82 normal equations and provided final or tentative elevations for 3,125 miles of first-order and 676 miles of second-order leveling.

The office processing of field astronomical observations was kept current. Seven latitudes, eight longitudes, and nine azimuths were computed, and seven Laplace azimuths were derived.

The pendulum observations for gravity made during the year in the United States and South America were processed and values of gravity, elevations of stations, and isostatic reductions were computed for those in the United States.

The effect of the weight of the water impounded in Lake Mead (Hoover Dam) upon the warping of the geoid in that region was computed.

Projection tables for charting purposes were computed. Computation of geodetic data for use in cartography included grid intersections for State plane coordinates, grid intersections for Lambert projection tables for aeronautical charts, and distances for the construction of electronic position indicator and Shoran curves on field survey sheets.

TIDE AND CURRENT SURVEYS

Tide and current surveys provide basic data for the surveying activities of the Bureau, for the prediction of tides and currents as an aid to water-borne commerce, and for the industrial development of our coastal harbors.

In hydrographic surveys, soundings must be corrected for the height of the tide so that the nautical chart will show all depths referred to a uniform datum. In photogrammetric surveys of coastal areas, the aerial photographs which are taken at various stages of the tide have to be adjusted so that the shoreline depicts conditions at high water. In geodetic control surveys, the datum of mean sea level, used in leveling operations, is determined from tide observations at various places along our coasts.

Tide and current predictions, which supply advance information on the rise and fall of the tide and the ebb and flow of the current, are prerequisites to safe navigation. These are made available to the mariner through publication of annual tide and current tables and through tidal current charts.

Engineering and construction projects associated with the industrial development of coastal harbors require data on the elevation of tidal datum planes and the circulation of the tidal waters. Structures, for example, have to be located so that they will not be flooded by high waters, and intake pipes for plants must be placed at the economical level and have an ample supply of water at all stages of the tide without increasing the height required to pump cooling water. Observational data on the ebb and flow of the current are essential in the solution of problems of sewage disposal and water pollution.

Supplementing these principal uses, there is an increasing demand for tide and current data for a number of collateral uses, such as fisheries, determination of boundaries of tidelands, offshore oil production projects, sports and recreational activities, and for investigations of slow changes taking place in the relation of land to sea.

During the year, the tidal program included the operation of 132 primary and secondary tide stations, 48 of which were located on the Atlantic and Gulf coasts, 16 on the Pacific coast, 13 in Alaska, 15 on Pacific islands, and 40 in Latin America. Of these, 88 stations were maintained in cooperation with other agencies, including the governments in Central and South America; the Department of State; various units of the Army, Navy, and Coast Guard; the Civil Aeronautics Administration; and municipal and scientific organizations.

The Bureau continued its participation in tidal investigations in Central and South America under the cooperation with the American Republics program of the Department of State and the Inter-American Geodetic Survey program of the Caribbean Defense Command of the Department of the Army.

The cooperative project for obtaining systematic tide observations in the western Pacific area was also continued, and 14 tide stations were in operation during the year.

To carry out the tidal surveys of the Bureau, a tide station servicing party was in operation in each of the following areas: Atlantic and Gulf coasts, Pacific coast, Pacific islands area, and South and Central America. During the summer months a subparty was engaged in bench mark recovery operations.

The results of the current survey of Delaware Bay and River were made available through the publication of tidal current charts for those waterways. A comprehensive current survey of Tampa Bay, Fla., was begun in October 1948. Data from this survey have been utilized to calculate daily predictions of the current for Tampa Bay entrance for publication in the current tables for 1950. The cooperative arrangement with the Coast Guard for obtaining hourly current observations throughout the year at Five Fathom Bank and Frying Pan Shoals Lightships was continued.

As a part of the oceanographic work of the Bureau, observations of temperature and density of sea water were taken at most of its tide stations in the United States as well as at a number of its cooperative tide stations in foreign countries. The data derived from these observations supply useful information to the shipping and fishing industries, to industrial plants using salt water, and to various scientific organizations. During the year, there were a total of 97 stations at which observational data were being obtained. Thermographs for continuous recording of fluctuations of sea water temperatures were in operation at six of these stations. A preliminary study of the thermograph records from Atlantic City reveals a correlation between variations in the temperature of the water and the rise and fall of the tide.

Progress on the processing of field records, including tide records from primary and secondary tide stations and from hydrographic surveys, and current meter records, has kept pace with field surveys. Leveling records were processed for 2,052 bench marks at 422 stations.

The program of special tidal studies for selected areas was kept current and 11 reports were prepared during the year.

Tide and current predictions for the year 1950 were completed for eight tide and current tables. Special tide and current predictions were also prepared for Navy establishments, for the Marine Corps School, Quantico, Va., and for the Coast Guard.

Exchange of tidal predictions was carried out with Canada, Argentina, England, France, Netherlands, Germany, and India Daily tide predictions for Bangkok Bar for the year 1950 were supplied to Siam.

For use in a study of the possible correlation between earth tides and volcanic activity special predictions of the vertical component of the tide-producing forces in the vicinity of Paricutin Volcano, Mexico, covering the periods February–August 1946 and September 1948–July 1949, were prepared for the United States Committee for the Study of Paricutin Volcano, National Research Council.

The development of the system for warning the Hawaiian Islands of an impending seismic sea wave was considerably advanced during the past year. Five seismic sea wave detectors were installed including a replacement at Honolulu. The new installations were made at Hilo, Midway, and Palmyra in the Pacific and at Dutch Harbor, Alaska. Arrangements were made to include a number of additional tide stations in the system as wave-reporting stations. Included are La Jolla, Calif., and Balboa, C. Z., and stations that are to be established at Kodiak, Alaska, and San Pedro, Calif. There are in all 18 wave-reporting stations in the system of which 5 are equipped with detectors. This warning system is a joint undertaking of the Coast and Geodetic Survey with the National Military Establishment and other agencies.

GEOMAGNETIC SURVEYS

The geomagnetic work of the Bureau was instituted over a century ago as one of the essential steps in the preparation of nautical charts. Magnetic observations have been made during many years at several thousand places in the United States and its Territories to determine the geographic distribution of important magnetic elements, especially magnetic declination, which varies in the United States from 22° west of north in Maine to 24° east of north in the State of Washington. Since the direction and intensity of the earth's magnetic field change with time, it is necessary to evaluate these changes by repeating observations at 5-year intervals at some 200 repeat stations uniformly distributed over the whole country. Systematic magnetic surveys provide data on magnetic declination, horizontal intensity, and dip, from which the magnetic field can be defined and magnetic charts compiled.

Using data compiled from magnetic surveys, the Bureau furnishes information to surveyors engaged in retracing old property lines originally established by compass bearings. Data are also supplied to individuals or agencies interested in studies of sun-spot activity, auroral and ionospheric disturbances, radio communications, and aids to navigation, and in geophysical prospecting for oil-bearing structures and mineral wealth.

During the year, continuous photographic records of the changes in the principal magnetic elements were obtained at magnetic observatories at Cheltenham, Md.; Honolulu, T. H.; San Juan, P. R.; Tucson, Ariz.; and at Sitka, College, and Barrow, Alaska. Automatic declination recording stations were continued in operation at Gatlinburg, Tenn., and Logan, Utah.

Field parties operated during part of the year obtaining data on the distribution of secular change in the United States.

Progress has been made in collecting and computing data for use in compiling a world isogonic chart, scheduled for issue in 1950. In accordance with agreements with the United States Hydrographic Office, the Bureau will be responsible for the compilation of this and other worldwide magnetic charts, and the charts will be published by the Hydrographic Office. The United States central library of world geomagnetic data has been maintained. The acquisition of important quantities of new material has improved its usefulness.

Processing of field and observatory data is now being expedited by a punch-card system. Instruction in geomagnetic operations and processing of data was given to representatives from other Federal agencies and to students from the Philippines, Peru, Venezuela, Siam, and China.

Revisions of magnetic declination data were made on several hundred nautical and aeronautical charts. Similar data are furnished regularly to the Army Map Service. Magnetic conditions, based on records at the Cheltenham Observatory, were reported daily to the Central Radio Propagation Laboratory of the National Bureau of Standards in connection with its program of forecasting radio transmission conditions. The weekly K-index report on magnetic conditions at Cheltenham Observatory was continued throughout the year.

Close cooperation was continued with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington on several major projects. This included maintenance of the International Magnetic Standard and operation of a cosmic ray station at Cheltenham Observatory, and the operation of an atmospheric-electricity recording station at Tucson Observatory.

The Bureau collaborated with the International Association of Terrestrial Magnetism and Electricity in the collection, reduction, and compilation of K and C numbers for the calendar year 1948, and with the Pan American Institute of Geography and History by assisting in the establishment of standards of magnetic practice for adoption by all American nations. Two complete magnetographs of American manufacture have been inspected and tested for the National University of Argentina and for the Philippine Government.

The following table shows the distribution of magnetic observations made by field parties during the year:

Distribution of magnetic observations

Location	Repeat stations				Other stations	Total
	New		Old			
	Complete [1]	Declination only	Complete [1]	Declination only		
Arkansas	2					2
California	1		1			2
Florida			1			1
Idaho					6	6
Illinois			2			2
Indiana		1			1	2
Kansas	2			1	2	5
Kentucky	1		2			3
Louisiana			1			1
Massachusetts					1	1
Michigan	1		1		2	4
Mississippi	1		3			4
Missouri	1		1			2
Nevada	1		1			2
Oklahoma	1		1			2
Pennsylvania		1	1			2
Tennessee				2		2
Texas	1		4			5
Vermont					1	1
Virginia					2	2
Washington					1	1
Alaska					57	57
Total	12	2	19	3	73	109

[1] A complete station comprises measurement of declination, horizontal intensity, and dip, thus completely defining the field.

SEISMOLOGY

Seismologic investigation in the Coast and Geodetic Survey was begun in 1925. The program is directed primarily toward the mitigation of loss of life and property in the United States due to earthquakes, and to conducting basic research of value in our national defense program. To accomplish these objectives the Bureau maintains a chain of seismograph stations to locate earthquakes and map areas of seismic risk; it cooperates with many universities to salvage valuable technical data that might otherwise be lost; it maintains a special field office in San Francisco to collect instrumental and noninstrumental information on earthquakes occurring in the seismically active West coast area; and maintains a staff in the Washington Office to conduct research, compile reports, and furnish information to the public.

In addition to these functions the Bureau was called on during the year to carry out research programs sponsored by other Federal agencies. It also took an active part in the field investigation of the Puget Sound earthquake of April 13, 1949, which caused a property loss of more than $30,000,000 and again focused public attention on the earthquake problem.

Normal teleseismic work involved the operation of 26 seismological observatories, processing the records for locating earthquakes, and publishing results. Fifteen of these stations were maintained in collaboration with universities or scientific institutions. Station data and bulletins were exchanged with other stations throughout the world. The epicenter service was carried out on a greatly expanded and faster basis. In addition to the cooperation of Science Service and the Jesuit

Seismological Association in this project, the State Department, the Public Buildings Administration, and the military services furnished communications facilities which supplied immediate seismological data from all parts of the world. Approximately 3,400 earthquake messages were received and 120 earthquake locations were announced within a day or two. A new service was inaugurated whereby the 250 subscribers to this information service are furnished additional information on minor shocks. This insures more satisfactory analysis of seismograph records for basic research by seismological stations operating independently.

To improve earthquake locations and make available more seismic data for research, the Bureau tested the vibration characteristics of a site at the University of Kansas, where a seismographic installation is proposed. At Overton, Nev., the station of the Lake Mead network was reactivated.

Keller visible-recording seismographs were installed at the magnetic observatories at College, Alaska; Tucson, Ariz.; and Honolulu, T. H. These installations are an essential part of a seismic sea wave warning service.

General statistical information on earthquakes was obtained from a corps of nearly 40,000 volunteer reporters representing interested business concerns, railroads, public utilities, the United States Weather Bureau, and other organizations. Information is thus made available on the intensity distribution of earthquakes and valuable statistical data are compiled for insurance companies. In nine western States this project is supervised by collaborators generally associated with the geological departments of State universities. About 3,000 descriptive reports were collected during the year. With the combination of seismographic data and descriptive reports, 185 earthquakes were located in the United States. Thirty earthquake areas were canvassed for detailed information.

Specially designed seismographs were maintained to record destructive ground motions for use in the design of structures. Forty-five such instruments are operated in the Pacific coast area, 4 in Montana, 4 in Nevada, 1 in Utah, and 7 in South and Central America. One hundred and four records were obtained of 24 earthquakes, the most important of which were 2 records of the Puget Sound earthquake. The ground motion at Olympia was as great as any thus far recorded on an instrument of this type.

As part of this engineering research program the Bureau measured building and ground vibrations to obtain pertinent data. Vibration observations were made in eight buildings and one tower, and the ground vibrations resulting from two heavy blasts fired on Tennessee Valley Authority projects in northeastern Tennessee were measured.

In California, an Earthquake Engineering Research Institute was organized, through the efforts of a committee under sponsorship of the Bureau, to conduct investigations in the undeveloped fields of structural dynamics and aseismic design. As an aid to this program, and through the sponsorship of the Office of Naval Research, plans were made to subject the Bureau's important strong-motion seismograph records to exhaustive analysis using the electrical analog computor at the California Institute of Technology. This work, too laborious for solution by individual computers, will provide informa-

tion regarding the response of oscillating structures of various natural frequencies, and thus advance the development of structural design practices.

Copies of seismograms from sensitive instruments as well as strong-motion records are regularly loaned to individuals and research agencies. Records of more than 30 different earthquakes were supplied for such special investigations. There was wide demand for a map showing earthquake risk in the United States, prepared last year with the help of leading seismologists of the country, for use in connection with building codes. The frequent occurrence of destructive shocks in the State of Washington made it necessary to modify the map and assign a higher earthquake probability to that area.

As a result of the Bureau's efforts, a Pan American association, including a library and central information bureau for seismological projects, has been organized under the auspices of the Commission on Cartography of the Pan American Institute of Geography and History. Assistance in instrumentation was furnished the Seismological Institute of Chile and the Geophysical Institute of Mexico in advancing their engineering-seismological programs, and conferences were held with many visiting seismologists and engineers from the southern republics on various phases of our program.

IMPROVEMENTS IN INSTRUMENTS, EQUIPMENT, AND TECHNIQUES

Because of its highly specialized activities, the Bureau has from its inception recognized the importance of developing new and improved instruments, equipment, and techniques in order that better results might be obtained at reduced costs. A radiosonic laboratory is maintained for the development and servicing of electronic equipment, and a research section for the improvement and development of aerial photographic mapping instruments and equipment. A modern shop is also maintained for servicing all instruments and equipment used in the Bureau's field and office work.

The Bureau cooperates with Federal, State, municipal, and private agencies in furnishing technical details on new instruments, methods, and practices. Foreign representatives, both governmental and private, frequently visit the Bureau to observe the new processes and acquire data on their performance.

A number of improvements were made during the year in the operating equipment used in hydrographic surveying. A model II electronic position indicator (EPI) was completed and tested under service conditions. The new model includes completely redesigned ground equipment and transmitters with synchronizer and antenna-attenuator. Two new type dural portable radio masts, 100 feet in height, were obtained for use at the EPI shore stations in Florida.

Ship-borne Shoran equipments were modified, including a new type antenna and reflector system, to permit the use of ships as ground stations. This will permit a wider use of Shoran in hydrographic survey control. Special graphs were designed to expedite the reduction of echo-sounding records, and a more efficient method was devised for making bar checks for calibration of echo-sounding equipment.

In connection with our electronic work, a new type of beam for beam

compasses has been developed for use in preparing Shoran and EPI plotting sheets. The new beam is made of magnesium instead of wood and has the desirable properties of lightness, stiffness, and freedom from warping.

Further improvement has been made in the quality, accuracy, and speed of stereoscopic contouring with the Reading plotter. The establishment of the photogrammetric test area during the previous fiscal year has made it possible to make more detailed studies of the requirements of adjustment of the nine-lens camera and its associated equipment. Toward the close of the fiscal year, a photo-theodolite was acquired for expediting the establishment of supplemental control for stereoscopic mapping in Alaska. With it, terrestrial photographs are taken from established stations and unknown points determined, to serve as control for aerial photographs.

New developments were made in connection with the seismic sea wave warning system for the Pacific area. Laboratory tests simulating the tide and seiche action at detector stations were made in order to facilitate the installation of sea wave detectors. Work was begun on the construction of a seismic sea wave travel time chart for each reporting station.

In the field of seismology, a method was developed for calibrating galvanometric seismographs by imposing a wide range of frequencies on the seismometer pendulum. The pendulum is forced into vibration by a specially designed electrical device that generates low frequency oscillatory currents. To insure more accurate recording of destructive earthquake motions, new type unifilar suspensions for strong-motion accelerographs were installed in all equipment on the West coast. New photographic recorders, designed for compactness and light weight, were built for seismological field operations.

Standard types of magnetic instruments for field and observatory use have been designed and are being manufactured by American firms. These instruments include earth inductors, magnetometers, magnetic variometers, and special photographic recorders for use in Arctic regions.

Improvements in our tide and current instruments included the following: The NK–7 portable depth recorder was modified for use as a tide gage, automatically controlled by a modified hydrographic clock and with a marigram scale of about 1 inch to 8.8 feet. Specially designed crystal controlled radio equipment to operate in the ultra high-frequency band has been procured for use with the Roberts radio current meter. The radio receiver of this equipment is capable of selecting any one of the signals from a possible 12 radio current meter transmitters at the will of the operator.

In the field of geodesy, several important improvements were made in equipment and techniques during the year. Among these are the following:

A new set of theodolite testing collimators was completed and installed on the interior walls of the gravity room in the basement of the Department of Commerce building. The instruments will be less affected by temperature changes and there will be less likelihood of interference during the testing.

The photographic process of producing precise level rods has been improved through the use of new and improved tools and procedures.

As a result, the time required to graduate a rod has been materially reduced, and the graduations can be applied with so high a degree of accuracy that rejections seldom occur even though the over-all tolerance in the 10-foot rod is only 0.004 inch.

A station mark of new design, produced by mechanical means instead of by casting, has been perfected during the year. This is the first major change in this item in many years. The new marker is one-half the weight of the cast mark, the legend on the face is sharper, and the cost of production will be less.

Improvements were initiated in signal lamp bulbs involving the centering of the filament and the quality of the glass, both of which will increase the range of the lamp.

A cold chamber has been built in the Bureau for testing instruments at temperatures of −40° F. and lower. Refrigeration is accomplished by the use of dry ice. The chamber is large enough to test a standard tide gage or an astronomic transit.

Several improvements have been made in our chart-reproduction methods. One is a method of creating an engraving ground on blank glass of large size suitable for engraving on the projection ruling machine. From these engraved plates, plastic prints and duplicate negatives and positives of various projections can be prepared.

Techniques have also been developed for improving the fit of junctions on the printing plates of nautical charts where more than one negative is required for a chart. The new procedure consists of a special method of correcting the junctions on the negatives before the plate is made and eliminates practically all lithographic drafting on the plate, heretofore a considerable task.

Two Monotype type-setting machines have been installed for composing and casting type for use on nautical and aeronautical charts. These machines furnish a long needed means of meeting the demands of the Bureau for type work.

Several high-speed calculating machines, using punched-card methods, were installed during the year. These methods were found applicable to our specialized activities and were used in the adjustment of extensive triangulation networks, in the harmonic analysis of tide and current data, in the computation of hourly values of magnetic components, and for computing pay rolls. The installation of these machines has resulted in the saving of many man-hours of labor.

FEDERAL AND INTERNATIONAL COOPERATION

Federal Agencies

The Bureau has cooperated with various governmental agencies in establishing horizontal and vertical control stations for use in their surveying and mapping and other engineering projects, and in making available to them information on our methods and techniques.

An important agreement was entered into with the Hydrographic Office of the Department of the Navy regarding publication of nautical charts of the Panama Canal. Under this arrangement, the Coast and Geodetic Survey will discontinue compiling and printing charts of the Canal, but will continue to make surveys of the areas and furnish the results to the Hydographic Office for use in maintaining the

charts. Responsibility for chart coverage of the area will rest with the Hydrographic Office for such period as is considered strategically necessary.

Close liaison was continued with the Civil Aeronautics Administration, through its regional offices, in the matter of exchange of information and prompt notification of developments in new techniques and new requirements. This on-the-spot contact by Coast and Geodetic Survey officers stationed in the CAA offices has proved beneficial to both Bureaus. Information received is screened at the regional office level and forwarded to Washington for application to our aeronautical charts. This program has resulted in important information being applied to the charts far in advance of its receipt through usual channels.

The Bureau cooperated with the Air Matériel Command in supervising the design of a special coordinate setting machine for use in the construction of aircraft jigs. This work was done under funds transferred from the Department of the Air Force. The Bureau will also supervise the construction of the machine.

Cooperation with the Department of Justice was continued in connection with the California submerged lands case. Advice was given the Department on technical aspects of the case and maps prepared for use as exhibits in supplementary briefs.

American Republics

The Bureau participated for the ninth consecutive year in the Cooperation With the American Republics program which is sponsored and financed by the Department of State. Participation embraces two major activities—an Exchange of Persons program, under which qualified trainees from the South American countries receive training in Coast and Geodetic Survey methods and procedures, and a Scientific and Technical program, under which the Bureau acts in a consultative and advisory capacity to these countries. These two programs are closely allied, and the operation and results of one are reflected in the progress made in the other.

Under the Exchange of Persons program, in-service training grants are offered to specific government agencies in geodetic surveying and in map and chart production. Grants include three categories, namely: Type A, financed entirely by the United States; type B, financed wholly by the foreign government; and type C, financed jointly. During the year, 18 grants were awarded, as follows: In map and chart production—Cuba (2), Ecuador (1), and El Salvador (1); in geodetic surveying—Bolivia (3), Chile (2), Cuba (2), Ecuador (1), El Salvador (1), Peru (3), and Venezuela (2). Of these, 14 grants were of type A, 2 of type B, and 2 of type C. Twenty-one trainees under the 1948 program, and one trainee under the 1947 program, continued their training in 1949.

The period of training covers 6 to 8 months. Emphasis is on the practical application of methods and procedures, supplemented by lectures and discussions on theory, with specific reference to the manuals and special publications of the Bureau. Wherever practicable, trainees are assigned to field parties to learn methods of party operation and for practical experience in the use of instruments.

In addition to these formal training grants, nine visitor trainees from several of the Central and South American countries received and were given instruction in Coast Survey methods at various periods.

In addition to the training received in the Bureau, trainees visit other governmental agencies to obtain as broad a view as possible of the activities in which they are interested. Many trainees affiliate with some of the national and international professional societies and technical organizations in order to keep abreast of the latest developments and techniques in surveying and mapping through publications and meetings of these bodies.

Under the Scientific and Technical program, five technical missions were sent to various countries during the year. These Bureau experts consulted with representatives of foreign government agencies and rendered advice concerning the planning and operation of broad programs in tides, geomagnetism and seismology, geodesy, photogrammetry, city surveys, and technical procedures and methods pertaining to cartographic activities.

Tide stations were operated on a cooperative basis at 40 ports in Central and South America under the American Republics program of the Department of State and the Inter-American Geodetic Survey program of the Department of the Army. In establishing tide stations, the Coast and Geodetic Survey furnishes the instrumental equipment and installs the stations. The cooperating countries furnish the sites, the housing for the instruments, and the observers. The tide-gage records are forwarded to the Bureau for analysis and processing, and the results are then distributed to the respective cooperating agencies. The observations are supplying valuable data for use in tide tables, for the construction of nautical charts, for engineering construction along the coast, for development of navigational aids, and for studies of changes in the relation of land to sea.

Cooperation continued during the year in the operation of strong-motion seismographs and the interpretation of the records at the following stations: Santiago, Chile; Lima, Peru; Quito, Ecuador; San Jose, Costa Rica; Guatemala City, Guatemala, and Balboa Heights, Panama. Instructions for calibrating these seismographs were furnished to Chile and Peru. Complete plans for the construction of an accelerograph were supplied Mexico and an instrument was loaned as a model for duplication.

Through the Department of State, telegraphic service was established with seismograph stations in Colombia, Peru, Bolivia, Brazil, and Argentina for the immediate location of earthquakes.

Almost from its inception, the over-all cooperation program has produced important benefits to the United States and to the other American Republics. Cordial relations have been established with military, naval, and civil departments; valuable scientific and technical data have been exchanged; and interest has been stimulated in the development and execution of broad surveying and mapping programs in many of the countries. A byproduct of this program has been the purchase of material and equipment in the United States by special missions and the individual trainees. Coast Survey methods have been adopted which contribute materially to the establish-

ment of standards of accuracy and technical procedure on a hemispheric basis. Such standards are being sponsored by the Commission on Cartography of the Pan American Institute of Geography and History at meetings of technical delegates from all the American Republics.

Other Governments

Under the Philippine Rehabilitation program, authorized by the Seventy-ninth Congress, the Bureau maintained a staff of experts in the Philippines to assist in field survey operations and to train selected groups of Filipinos. In addition, two groups, of 10 trainees each, received instruction and training in the United States in survey methods. This program will continue until June 30, 1950, when survey operations will be transferred to the Philippine Government.

The Bureau cooperated with the Governments of India, Portugal, Siam, and Turkey, in training technicians from these countries in Coast Survey methods. The training is financed entirely by the foreign governments concerned. During the year seven such trainees received instruction.

Technical advice in geomagnetic operations and processes was given representatives from Mexico, Peru, and Bolivia, and they were furnished with quartz fibers and metallic suspensions for magnetic instruments. Information on engineering seismology was given to the director of the Seismological Institute at Santiago, Chile, and representatives from Peru were instructed in the operation of seismographs and analyses of records.

REPRESENTATION ON COMMISSIONS, BOARDS, AND PANELS

The Bureau has maintained representation and membership on a number of commissions, boards, panels, and committees, in order to keep abreast of scientific and technical developments, both national and international, in the fields of activity in which it is interested, and to contribute its specialized knowledge to the study of future national needs. Membership in some of these is defined by law or by Executive order, while in others the cooperation of the Bureau is voluntarily sought. Some of the more important and active of these groups are the following:

Mississippi River Commission.—The Director of the Bureau continues to serve as the Coast and Geodetic Survey member of the Mississippi River Commission. The commission is responsible for the improvement and maintenance of the Mississippi River, from Cairo, Ill., to the Gulf of Mexico, for flood control, for promoting navigation, and for facilitating commerce on the river.

Research and Development Board.—The Director is an advisory member of the Committee on Geophysics and Geography of the Research and Development Board of the National Military Establishment. The Chief of the Division of Geomagnetism and Seismology and the Chiefs of these Branches, the Assistant Chiefs of the Divisions of Photogrammetry and Tides and Currents, and personnel of

the Divisions of Geodesy and Coastal Surveys are active members or deputy members of the various panels of the Board. Advice and recommendations have been given the Board on such studies as the further development of electronic survey systems, and obtaining more accurate knowledge of the shape and size of the earth.

Air Coordinating Committee.—The Chief of the Aeronautical Chart Branch represents the Department of Commerce and is chairman of the Subcommittee on Aeronautical Charts, Technical Division, Air Coordinating Committee. The Air Coordinating Committee was established by Executive order to coordinate the aviation activities of the Federal Government and deals with such matters as standardization of symbols and specifications for aeronautical charts.

International Civil Aviation Organization.—An officer of the Bureau, on detached service, is the United States representative on the Council of the International Civil Aviation Organization (ICAO). This organization deals with all phases of civil aviation on an international level, particularly with regard to promoting safety, developing standards, and encouraging uniform procedures. The Bureau is represented on the committee making recommendations to the ICAO Council on Dimensional Standardization.

Pan American Institute of Geography and History.—The Director of the Bureau is a member of the United States Advisory Committee on American Cartography for the Commission on Cartography of the Pan American Institute of Geography and History. The Bureau is represented on several of the technical committees of the Commission on Cartography. The Commission was set up in 1941 for the purpose of facilitating and expediting progress in map making in the nations of the Western Hemisphere, through the interchange of ideas, the exchange of information, and the promulgation of standards for the various classes of maps and surveys.

Woods Hole Oceanographic Institute.—The Director of the Bureau is a trustee of the Woods Hole Oceanographic Institute, a research establishment supported by endowment to encourage and carry on the science of oceanography in all its branches.

Miscellaneous representation on boards, etc.—The Bureau has official representation on a number of scientific and technical associations and committees, among which are the United States Board on Geographic Names; Federal Specifications Board; American Standards Association; Advisory Committee on Engineering Seismology; American Committee on Paricutin Volcano; Radio Technical Committee for Marine Services; Joint Mapping Photographic Committee of the Joint Chiefs of Staff; Interdepartmental Radio Advisory Committee, Federal Communications Commission; Navy Arctic and Cold Weather Coordinating Committee; Joint Service Board on Foreign Station Allowance; Earthquake Research Institute; Civil Service Committee of Expert Examiners; Committee on Surveying and Mapping, and faculty of the Graduate School, Department of Agriculture; and Advisory Council, Department of Civil Engineering, Princeton University.

In addition, there are other scientific and engineering groups in which membership is voluntary, but which the Bureau encourages

because they provide a forum for the mutual interchange of ideas and for bringing the Bureau's activities and progress to the attention of scientists, engineers, and others. Our personnel hold executive positions or head technical committees in these organizations, among which are the American Geophysical Union; American Congress on Surveying and Mapping; American Society of Photogrammetry; Institute of Navigation; United States Power Squadrons; International Union of Geodesy and Geophysics; International Association of Terrestrial Magnetism and Electricity; International Society of Photogrammetry; International Seismological Association; American Society of Civil Engineers; the Society of American Military Engineers; Washington Academy of Sciences; and Seismological Society of America.

PERSONNEL AND FINANCES

The number of persons in the service of the Coast and Geodetic Survey at the close of the fiscal year was 2,491.

Civilian personnel actions during the year included 1,731 appointments, 1,239 separations, 26 retirements, 412 line promotions, and 1,064 within-grade promotions. Of the 1,731 appointments effected, 2 were employees who returned to duty from military furlough and 613 were veterans.

Commissioned personnel changes included 7 retirements, 2 resignations, and promotions, as follows: 6 deck officers to ensigns, 2 lieutenants (jg.) to lieutenants, 16 lieutenant commanders to commanders, and 8 commanders to captains.

At the end of the fiscal year one officer was serving as instructor in surveying at the Field Artillery School, Fort Sill, Okla. Another officer was assigned as survey expert with the Field Artillery Test Section of Army Ground Forces Board No. 1 at Fort Bragg, N. C. One officer completed the 5-months' course at the Armed Forces Staff College at Norfolk, Va., the fourth officer to complete such course. Three officers were attached to the Inter-American Geodetic Survey for liaison duties in surveying and mapping in South and Central American countries. One officer, based at Honolulu, was assigned to a project for obtaining systematic tide observations in the western Pacific in cooperation with the Corps of Engineers.

One officer was serving as representative of the United States on the Council of the International Civil Aviation Organization.

One cartographic engineer continued as liaison officer between the Bureau and the Civil Aeronautics Administration.

Three officers, two mathematicians, one cartographer, an electronic scientist, and a clerk continued on duty in the Republic of the Philippines under the Philippine Rehabilitation program.

A new pay system was established on May 1, 1949, for vessel employees. It provides longevity pay increases for up to 30 years' service.

The following table is a break-down of the number of employees in the Bureau by regular appropriations and other funds as of June 30, 1949. Part-time fixed-fee employees and dollar-a-year men have been omitted from this table.

Distribution of personnel by appropriations, June 30, 1949

Appropriation	Commissioned	Civilian	Total
Washington office:			
Regular appropriations	24	924	948
Working funds		50	50
Philippine rehabilitation		6	6
Cooperation with American Republics		7	7
Total, Washington office	24	987	1,011
Field service:			
Regular appropriations	130	1,279	1,409
Working funds		64	64
Philippine rehabilitation		5	5
Total, field service	130	1,348	1,478
On duty with military forces	2		2
Total	156	2,335	2,491

Collections covering miscellaneous receipts, including nautical and aeronautical charts and related publications, totaled $347,218 as compared with $422,677 during the preceding year.

The following funds, from the sources indicated, were made available to the Bureau during the fiscal year 1949:

Available funds

Regular appropriation:	
Salaries and expenses, departmental	$3,400,000
Salaries and expenses, departmental, second deficiency appropriation	257,000
Salaries and expenses, field	5,600,000
Salaries and expenses, field, first deficiency appropriation	366,000
Pay and allowances, commissioned officers	1,255,000
Total appropriations	10,878,000
Reimbursements from other departments to credit of appropriation for:	
Salaries and expenses, departmental	153,900
Salaries and expenses, field	26,473
Total reimbursements	180,373
Working funds received from:	
Department of the Army:	
Picture-point triangulation along north side of Seward Peninsula, Alaska	310,000
Establishment of geodetic surveys, I. A. G. S	302,046
Triangulation and base measurements at Aberdeen, Md	7,500
Processing tidal records	50,000
Department of the Navy:	
Surveys in vicinity of Naval Station, Long Beach, Calif	20,000
Hydrographic Office (isomagnetic charts)	11,900
Hydrographic Office (calibrating and standardizing instruments)	1,500
Hydrographic Office (special charts and maps)	60,000
Naval ordnance test station (determination of geographic positions and elevations of control points, Chincoteague, Va	15,000
Department of the Air Force:	
Meteorology equipment for aircraft production	10,000
Aeronautical charts	369,000
Classified project	76,000

Available funds—Continued

Working funds received from—Continued	
Department of the Interior:	
Survey of Franklin D. Roosevelt Lake	$20,000
Seismological stations at Hoover, Grand Coulee, Shasta, and Hungry Horse Dams	14,500
Atomic Energy Commission (special maps and charts)	70,000
Civil Aeronautics Administration:	
Airport surveys	10,000
Special aeronautical charts	38,000
Total working funds	1,385,446
Transfer from: Department of State (Philippine rehabilitation)	386,929
Allotments from:	
Department of State (Cooperation with American Republics)	82,494
Department of Commerce (printing and reproduction)	141,000
Total funds received	13,054,242

PUBLICATIONS

The results of the surveys and investigations made by the Bureau are made available to the public in the form of charts, maps, and printed publications, and processed material. These include the following:

NAUTICAL CHARTS AND COAST PILOTS for use by the Navy, Merchant Marine, fishing industry, and the small pleasure-boat owner.

AERONAUTICAL CHARTS for use by the armed services, commercial air carriers, and private pilots.

PLANIMETRIC MAPS of coastal areas for use in charting and for planning engineering and other construction.

GEODETIC CONTROL DATA (triangulation, leveling, and gravity) for use by Federal, State, and local mapping and engineering agencies, by private surveyors and engineers, and by scientific investigators.

TIDE AND CURRENT PUBLICATIONS (tide and current tables, tidal current charts, and special tide and current surveys) for use in navigation, coastal construction, water-front litigation, and scientific investigations.

GEOMAGNETIC PUBLICATIONS for use by Federal mapping and charting agencies, by local surveyors in boundary surveys, and by geophysical prospectors in search for oil and other minerals.

EARTHQUAKE REPORTS for use by construction engineers in the design of earthquake-resisting structures, by geologists and insurance statisticians in earthquake areas, and by scientists in the study of earthquake phenomena.

Nautical and aeronautical charts are printed at the Washington office and are sold to the public at the various field stations of the Bureau, at the Washington office, and at authorized agencies located at strategic places throughout the country. Certain related chart publications, such as chart catalogs, and processed pamphlets giving results of field surveys, are distributed on request from the Washington office. Planimetric maps based on aerial photographs are printed and sold from the Washington office. Manuals and other publications of the Bureau are printed and sold by the Government Printing Office.

During the year new publications were issued in the following categories:

Coast Pilots

Coast pilots are volumes published for use with nautical charts. They contain a wide variety of descriptive information for the benefit of the surface navigator. New editions of the Alaska Coast Pilot, part II, and the Atlantic Coast Pilot, section D, were released for issue. New editions of the West Indies Coast Pilot and the Gulf Coast Pilot were in press. Supplements were also issued for the seven Coast Pilots which were not in process of revision.

Topography

The manuscript for part II of Special Publication No. 249, Topographic Manual, was sent to the printer. This manual will supersede Special Publication No. 144, which covers ground topographic surveying, and all previous photogrammetric instructions. Part II, which covers photogrammetric work, is being published first because the need for this part of the manual is greater.

Geodesy

In the field of geodesy, several new publications were issued. These included: Special Publication No. 240, Manual of Leveling Computation and Adjustment; Special Publication No. 241, Natural Tables for the Computation of Geodetic Positions, Clarke Spheroid of 1866; and Special Publication No. 242, Definitions of Terms Used in Geodetic and Other Surveys. Revised editions were also issued of Special Publication No. 226, Control Leveling, and Serial 562, Plane-Coordinate Systems. Manuscripts were sent to the printer for the following new publications: Special Publication No. 243, Fundamental Tables for the Deflection of the Vertical; Special Publication No. 244, Pendulum Gravity Data in the United States; Special Publication No. 245, Equal-Area Projections for World Statistical Maps; and Special Publication No. 246, Sines, Cosines, and Tangents, Ten Decimal Places with Ten-Second Interval, 0°–6°.

Tides and Currents

Tide and Current Tables, giving advance information on the rise and fall of the tide and the ebb and flow of the current for numerous ports and waterways throughout the world, are published annually in advance. Eight tables were prepared for the year 1950. The current tables, east coast, North and South America, 1950, include, for the first time, daily predictions of the current for Tampa Bay entrance, Florida. Data for the calculation of these predictions were obtained from the current survey now in progress in Tampa Bay. A new publication, Tidal Current Charts, Delaware Bay and River, and a revised edition of Tidal Current Charts, Boston Harbor, were issued. These charts consist of a series of 12 and depict the direction and velocity of the tidal current throughout the waterway for each hour of the tidal cycle.

Index maps of tidal bench marks and loose-leaf compilations of descriptions and elevations of tidal bench marks for Massachusetts,

Rhode Island, Connecticut, Alabama, and Mississippi were completed during the year. This information is issued for the use of surveyors and engineers in coastal construction and other engineering projects.

A revised edition of publication TW–2, Surface Water Temperatures, Pacific Ocean, and a pamphlet, Seismic Sea Wave Warning System with Instructions for Wave Reporting Stations, were also issued.

Geomagnetism and Seismology

In the field of geomagnetism, 16 of the MG series of magnetic observatory reports were issued. Each report contains quarter-size reproductions of magnetograms obtained at one observatory over a period of 6 months. Other publications being printed are: Serial 690, Magnetic Observations in the American Republics 1945–48; Serial 717, Magnetic Declination in Texas; Serial 718, Magnetic Surveys; and Serial 726, Magnetic Poles and the Compass.

Seismologic publications issued during the year included Abstracts of Earthquake Reports for the Western Mountain Region through the fourth quarter of 1948, the Engineering Seismology Bulletin through March 1949, and the quarterly Seismological Bulletins through June 1945. The manuscript for Special Publication No. 250, the Determination of True Ground Motion from Seismograph Records, was sent to the printer.

Miscellaneous

The second number of the Journal of the Coast and Geodetic Survey was issued during the year. This publication was initiated for the purpose of keeping our widely scattered field parties, as well as our office personnel, abreast of new improvements in methods and equipment that are constantly taking place in both field and office. Considerable interest has developed in the Journal among the personnel of the Bureau. Requests for reprints of articles show a wide diversity of interest in the publication. Engineering colleges and scientific organizations, interested in the procedures and technical operations of the Survey, are finding the Journal useful for reference purposes.

An illustrated handbook was published as a convenient source of information covering the technical services of the Bureau and the various types of data that are published for the use of the mariner, aviator, and engineer. Another pamphlet, The United States Coast and Geodetic Survey, describes the Bureau activities in a less technical manner and replaces a similar pamphlet, now obsolete. Considerable saving in time results from the availability of such handbooks and pamphlets in filling requests for information on the work of the Bureau and in assisting in a field recruitment program.

A number of papers, lectures, and miscellaneous items were prepared during the year for presentation before scientific and technical bodies and for publication in technical journals, encyclopedias, and year books.

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